April 27, 1960

ENVIRONMENTAL LEVELS OF RADIOACTIVITY

Report for 1959

Data Compiled by: H. H. Abee

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Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to earthen pits located in the Conasauga shale formation. Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

Due to the nature of operations at the three Oak Ridge installations (ORNL, ORGDP, Y-12), there is some variation in methods of monitoring and reporting of results. Therefore, monitoring methods as they are employed at each of the three installations will be discussed.

OAK RIDGE NATIONAL LABORATORY (X-10)

Air Monitoring

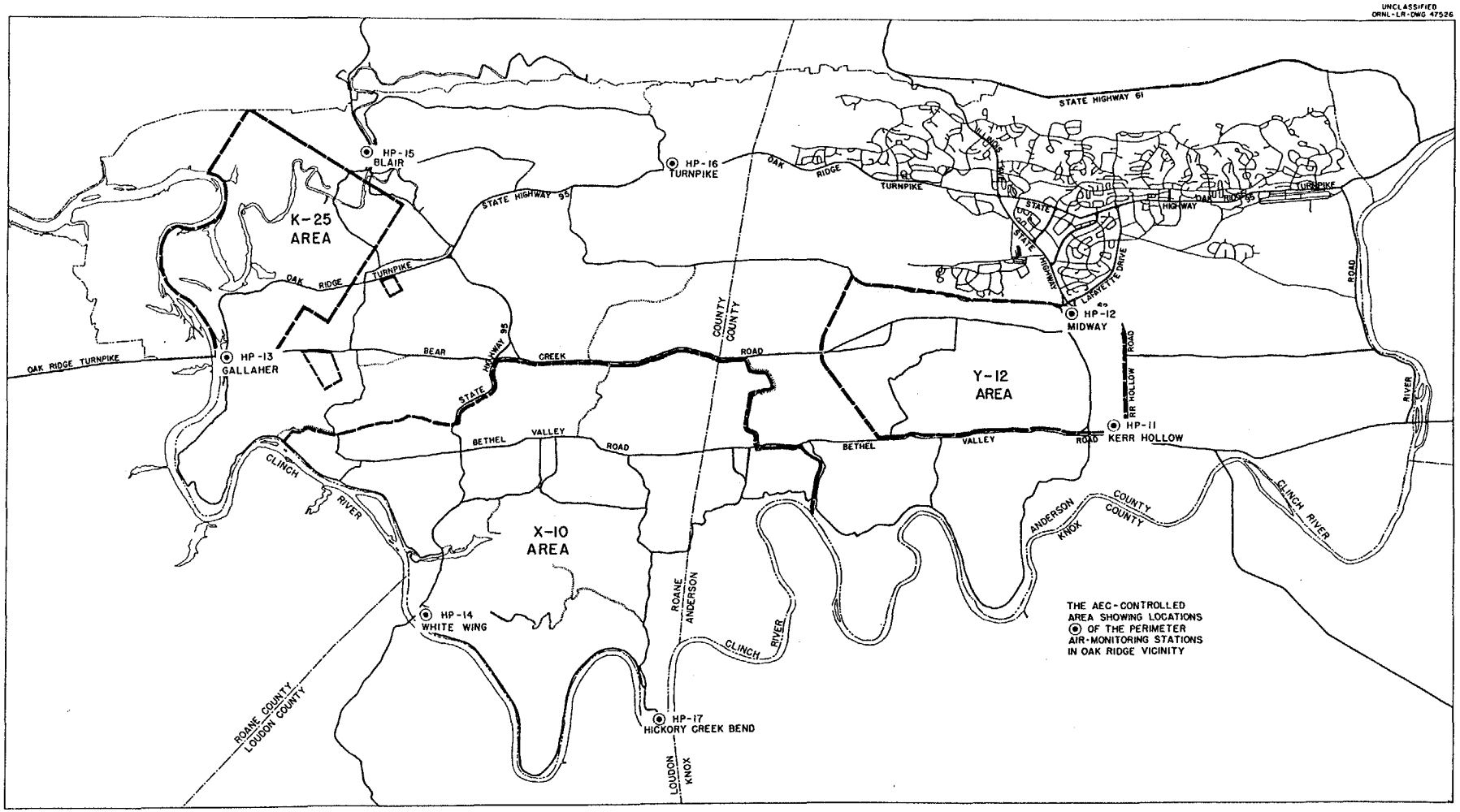
Atmospheric contamination and fall-out occurring in the general environment of East Tennessee are monitored by two systems of monitoring stations. One system consists of seven stations which encircle the plant areas (Fig. 1) and provides data for evaluating the impact of all Oak Ridge operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 120 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur.

Three types of samples are collected at the stations. One type is taken by passing air continuously through filter paper. The filter paper will collect only those particulates considered to be respirable. A second type utilizes a gummed paper technique for collecting fall-out. The fall-out trays collect the heavier particles as well as the respirable particles. A third type is rain water which provides data for determining the soluble and insoluble fractions of the radioactive contamination.

Data obtained from the various sampling methods are accumulated and tabulated. In the case of the filter samples, data are tabulated in average $\mu c/cc$ of air sampled and numbers of particles per 1000 ft^3 of air sampled. In the case of gummed paper fall-out collection, data are tabulated in $\mu c/ft^2$ and numbers of particles per ft^2. In the case of rain water, data are tabulated in average $\mu c/cc$ of rainfall collected. The data are compared to established maximum permissible concentrations and with previous averages.

Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population in the neighborhood of a controlled area as recommended by the National Committee on Radiation Protection (NCRP). The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.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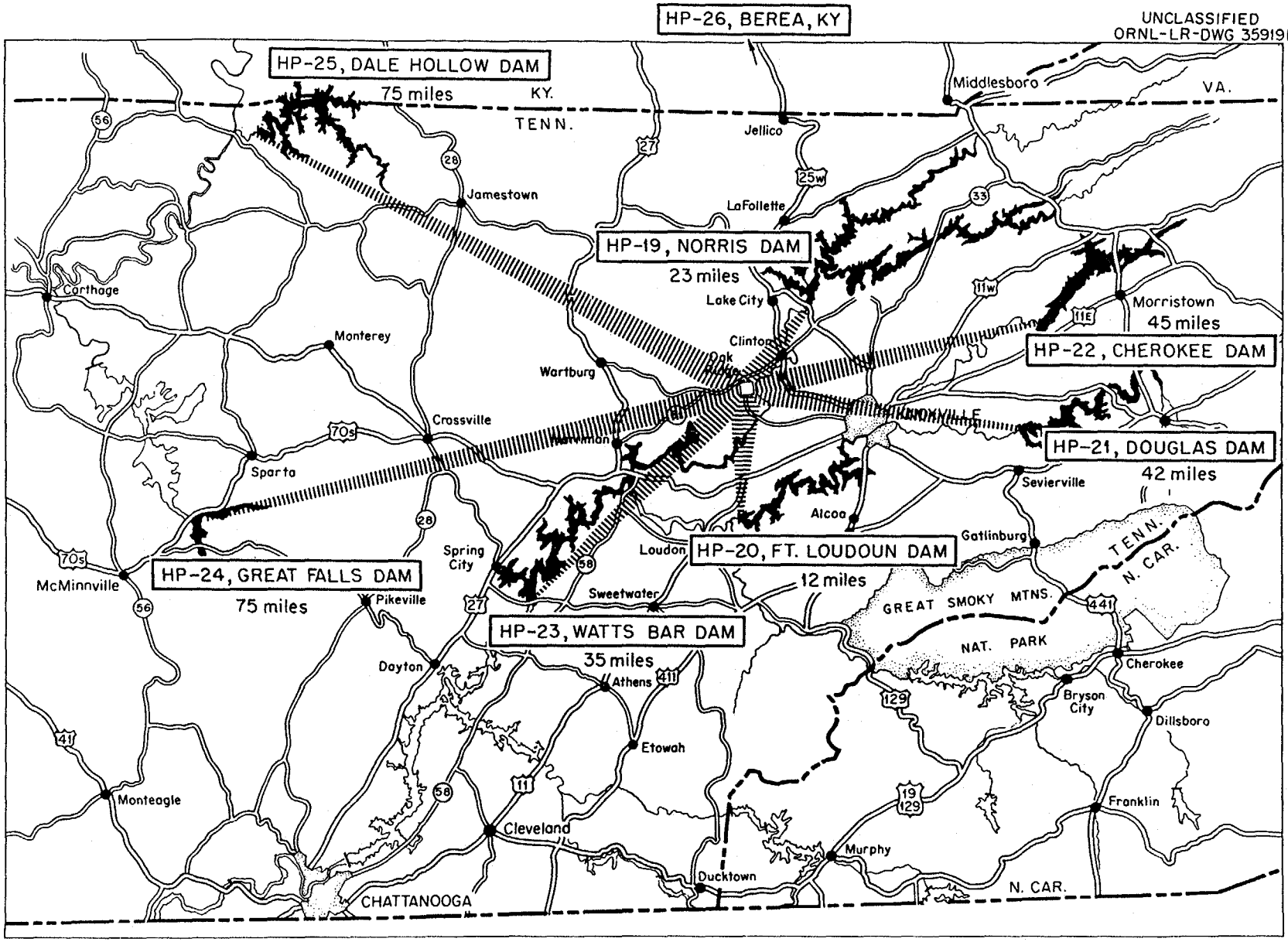
AREA
RR HOLLOW ROAD
HP-11
KERR HOLLOW
BETHEL VALLEY ROAD
CLINCH RIVER
X-10
AREA
ANDERSON COUNTY
KNOX COUNTY
HP-14
WHITE WING
ROANE COUNTY
LOUDON COUNTY
HP-17
HICKORY CREEK BEND
THE AEC-CONTROLLED
AREA SHOWING LOCATIONS
OF THE PERIMETER
AIR-MONITORING STATIONS
IN OAK RIDGE VICINITY

Figure 1



STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Figure 2

Radioactive liquid wastes leaving the Laboratory are sampled at a number of locations as shown in Fig. 3. Daily samples are taken where the effluent leaves the Laboratory, at a point where wastes enter the public waterway, and at Centers Ferry near Kingston, Tennessee, the first population center downstream from the A.E.C. controlled areas. In order to establish background conditions, daily samples are collected also in the Clinch River 17 miles upstream from the point of entry of the waste. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the concentrations of wastes in the river.

The fraction of the total beta activity comprised by each isotope is determined from analysis of long-lived radionuclides contained in the effluent and a weighted average maximum permissible concentration for water, $(MPC)_w$, for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as recommended by the NCRP. The average concentrations of radioactivity in the Clinch River are compared to the calculated $(MPC)_w$ value.

Annual surveys of the Clinch and Tennessee Rivers are conducted to determine the extent of dispersion of radioactive material in river sediment. This survey is required in order to determine whether or not there is a significant build-up of radioactive constituents in the river system. Gamma radiation measurements are made on the bottom sediments. Sediment samples are radiochemically analyzed for long-lived radioactive isotopes.

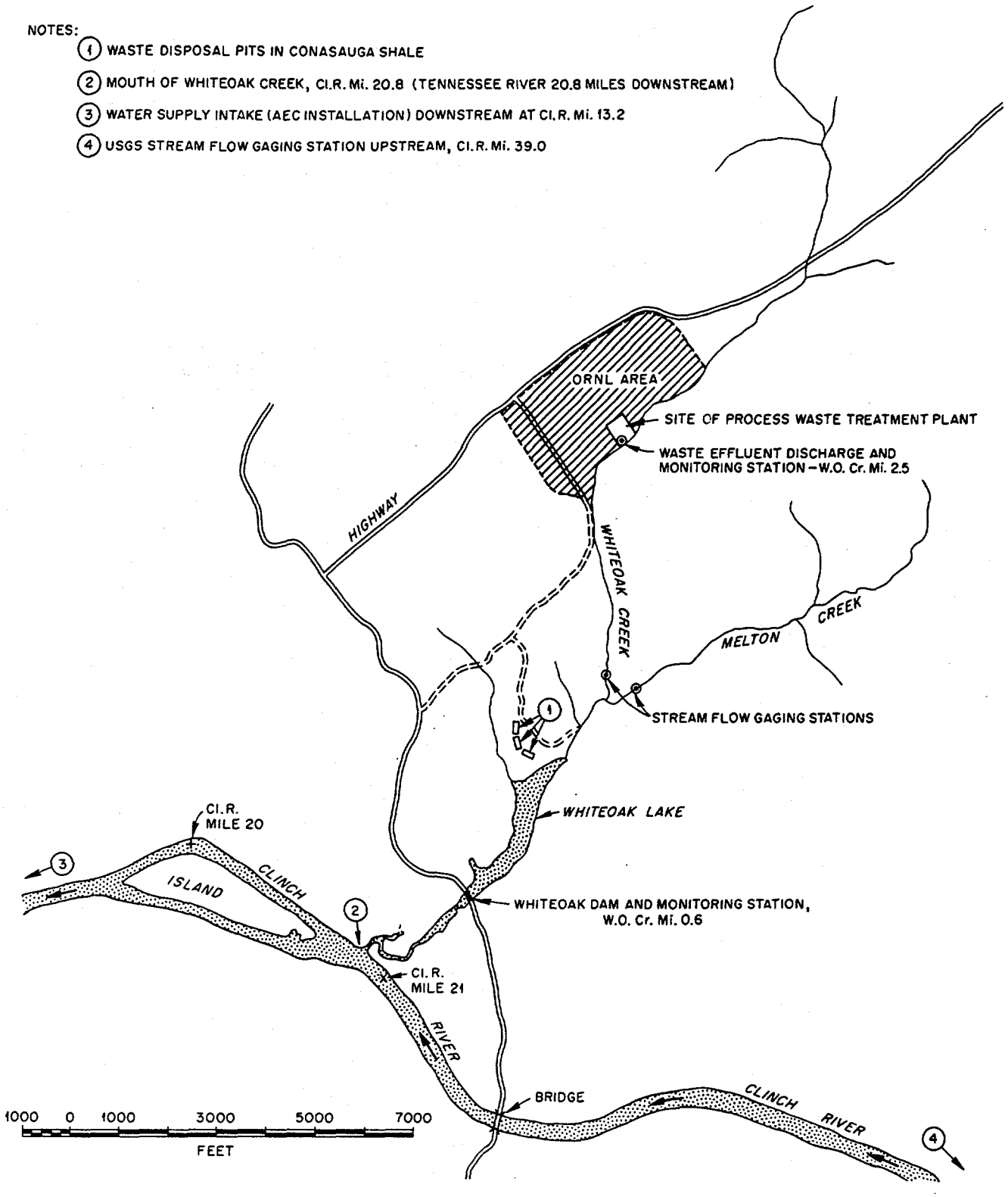
Gamma Measurements

External gamma radiation levels are measured monthly at five locations in the Oak Ridge area. Measurements are taken with a Geiger-Muller tube at a distance of three feet above ground and the results are tabulated in terms of mr/hr.

Discussion of Data

Data accrued from the monitoring system in 1959 are presented in Tables I through VIII.

The air contamination levels shown by the continuous air monitoring systems for the immediate and remote environs of the Oak Ridge area were 1.6% and 1.4% respectively of the maximum permissible concentration for populations in the neighborhood of a controlled area. Air contamination levels during the first half of 1959 were a factor of 4 to 6 times greater than the average for the entire year. By the end of 1959 air contamination levels had decreased to approximately 1/5 the value given for the yearly



Location Sketch Map
ORNL Area Surface Drainage

Figure 3

average. Specific analysis for fission products and decay studies indicated that the high levels experienced during the first part of the year were due to the type of fall-out from world-wide weapons testing. The low values for remote stations 23 and 24 resulted from the fact that these stations were in operation only during the latter half of 1959 and do not reflect the higher fall-out levels experienced during the first half of the year.

Fall-out data and rain water data followed the same trend shown by the continuous air monitoring data.

The probable average concentrations of radioactivity in the Clinch River at Mile 20.8, the point of entry of the wastes, and at Mile 4.5, near Kingston, Tennessee, were 3.1×10^{-7} μc/cc and 4.9×10^{-8} μc/cc respectively. These values are 25.4% and 22.3% of the weighted average maximum permissible concentration for populations in the neighborhood of a controlled area as recommended by the NCRP. The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 3×10^{-10} μc/cc, which is 0.03% of the weighted average $(MPC)_w$ value.

The concentration of radioactivity in the sediment of the Clinch River drops off materially after the first 20 miles downstream from the entry of White Oak Creek and approaches background levels 200 miles downstream. The average radiation level for the cross section where the highest levels were encountered was approximately 19 times the measured background levels or 0.12 mr/hr. This point is located 4.5 miles below the outfall of White Oak Creek. At 100 miles downstream the average level was approximately twice background.

External gamma radiation levels in the Oak Ridge area averaged 0.024 mr/hr. This level does not differ significantly from the average of the levels measured throughout the United States by the U. S. Public Health Service Radiation Surveillance Network.

TABLE I

CONTINUOUS AIR MONITORING FILTER DATA

Units of 10^{-13} µc/cc

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average	% of $(MPC)_a$*
		Perimeter Stations				
HP-11	Kerr Hollow Gate	52	47.52	0.49	15.77	1.6
HP-12	Midway Gate	49	81.31	0.08	16.29	1.6
HP-13	Gallaher Gate	52	58.52	0.54	16.63	1.7
HP-14	White Wing Gate	52	42.48	0.49	11.30	1.1
HP-15	Blair Gate	52	61.06	0.45	19.97	2.0
HP-16	Turnpike Gate	52	51.61	0.28	13.48	1.4
HP-17	Hickory Creek Bend	52	60.27	0.17	16.86	1.7
Average					15.76	1.6
		Remote Stations				
HP-19	Norris Dam	52	86.20	0.57	23.23	2.3
HP-20	Loudoun Dam	52	90.49	0.65	22.11	2.2
HP-21	Douglas Dam	37	58.17	0.68	10.91	1.1
HP-22	Cherokee Dam	39	100.52	0.52	16.01	1.6
HP-23**	Watts Bar Dam	29	35.14	0.49	5.13	0.5
HP-24**	Great Falls Dam	26	10.58	0.24	2.53	0.3
HP-25	Dale Hollow Dam	46	78.91	0.76	18.04	1.8
HP-26	Berea, Kentucky	52	54.27	0.14	13.77	1.4
Average					13.97	1.4

* $(MPC)_a$ is taken to be 10^{-10} µc/cc as recommended in NBS Handbook 69, Table 4, p. 94.
** Stations in operation only during latter half of 1959.

TABLE II

CONTINUOUS AIR MONITORING FILTER DATA

Particles/1000 cu. ft. of Air Sampled

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	6.27	0.00	1.20
HP-12	Midway Gate	49	6.81	0.00	1.29
HP-13	Gallaher Gate	52	5.08	0.00	0.95
HP-14	White Wing Gate	52	5.91	0.00	0.82
HP-15	Blair Gate	52	10.29	0.00	1.52
HP-16	Turnpike Gate	52	5.39	0.00	0.86
HP-17	Hickory Creek Bend	52	7.22	0.00	1.02
Average					1.09
		Remote Stations			
HP-19	Norris Dam	52	7.98	0.00	1.64
HP-20	Loudoun Dam	52	6.61	0.00	1.43
HP-21	Douglas Dam	37	2.83	0.00	0.28
HP-22	Cherokee Dam	39	7.26	0.00	0.54
HP-23*	Watts Bar Dam	29	0.40	0.00	0.05
HP-24*	Great Falls Dam	26	0.14	0.00	0.02
HP-25	Dale Hollow Dam	46	7.96	0.00	1.01
HP-26	Berea, Kentucky	52	5.83	0.00	1.10
Average					0.76

* Stations in operation only during latter half of 1959.

TABLE III

GUMMED PAPER FALL-OUT DATA

Units of 10^{-4} μc/sq. ft.

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	17.59	0.14	5.01
HP-12	Midway Gate	52	18.64	0.23	5.01
HP-13	Gallaher Gate	52	17.15	0.18	4.63
HP-14	White Wing Gate	52	16.87	0.18	4.86
HP-15	Blair Gate	52	23.55	0.15	5.37
HP-16	Turnpike Gate	52	28.88	0.15	5.03
HP-17	Hickory Creek Bend	52	15.17	0.14	4.41
Average					4.90
		Remote Stations			
HP-19	Norris Dam	52	23.53	0.12	4.36
HP-20	Loudoun Dam	51	14.97	0.05	4.17
HP-21	Douglas Dam	37	15.20	0.04	1.99
HP-22	Cherokee Dam	39	13.45	0.07	2.51
HP-23*	Watts Bar Dam	28	4.55	0.10	0.71
HP-24*	Great Falls Dam	26	2.75	0.12	0.63
HP-25	Dale Hollow Dam	46	20.75	0.14	4.26
HP-26	Berea, Kentucky	52	22.02	0.05	4.88
Average					2.94

* Stations in operation only during latter half of 1959.

TABLE IV

GUMMED PAPER FALL-OUT DATA

Particles/sq. ft.

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	77.00	0.00	11.96
HP-12	Midway Gate	52	97.00	0.00	12.85
HP-13	Gallaher Gate	52	84.00	0.00	10.50
HP-14	White Wing Gate	52	82.00	0.00	10.13
HP-15	Blair Gate	52	97.00	0.00	12.15
HP-16	Turnpike Gate	52	76.00	0.00	9.50
HP-17	Hickory Creek Bend	52	59.00	0.00	9.50
Average					10.94
		Remote Stations			
HP-19	Norris Dam	52	47.00	0.00	6.23
HP-20	Loudoun Dam	31	46.00	0.00	5.27
HP-21	Douglas Dam	37	14.00	0.00	0.51
HP-22	Cherokee Dam	39	11.00	0.00	0.90
HP-23*	Watts Bar Dam	28	3.00	0.00	0.41
HP-24*	Great Falls Dam	26	3.00	0.00	0.19
HP-25	Dale Hollow Dam	46	59.00	0.00	4.54
HP-26	Berea, Kentucky	52	63.00	0.00	7.19
Average					3.16

* Stations in operation only during latter half of 1959.

TABLE V

RADIOACTIVITY IN RAIN WATER

Units of 10^{-7} μc/cc

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	44	42.59	0.11	7.22
Hp-12	Midway Gate	44	40.38	0.14	6.30
HP-13	Gallaher Gate	44	38.72	0.12	6.10
HP-14	White Wing Gate	43	43.47	0.09	6.53
HP-15	Blair Gate	39	39.36	0.19	5.78
HP-16	Turnpike Gate	44	54.84	0.15	8.82
HP-17	Hickory Creek Bend	43	54.18	0.10	8.14
Average					6.98
		Remote Stations			
HP-19	Norris Dam	45	89.98	0.13	11.26
HP-20	Loudoun Dam	49	138.47	0.04	14.65
HP-21	Douglas Dam	31	36.68	0.06	3.86
HP-22	Cherokee Dam	33	32.20	0.13	4.41
HP-23*	Watts Bar Dam	23	6.89	0.20	1.32
HP-24*	Great Falls Dam	21	8.22	0.07	1.41
HP-25	Dale Hollow Dam	41	41.00	0.21	8.02
HP-26	Berea, Kentucky	44	47.28	0.14	10.14
Average					6.88

* Stations in operation only during latter half of 1959.

TABLE VI

PROBABLE AVERAGE CONCENTRATION OF RADIOACTIVITY
IN THE CLINCH RIVER AT MILE 20.8

Units of 10^{-7} μc/cc

1959

Number of Samples Taken	Maximum	Minimum	Average	% of $(MPC)_w$
365	36.4	0.37	3.1	25.4

TABLE VII

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS
IN THE CLINCH RIVER

1959

Location	Sampling Period	Units of 10^{-8} µc/cc Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	Probable Avg. Concen. of Radioactivity µc/cc x 10^{-8}	$(MPC)_w^a$ 10^{-6} µc/cc	% of MPC
Clinch River									
Mi. 37.5	10/1/59 - 1/29/60	0.11	0.10	*	*	*	0.45	0.21	2.14
Mi. 20.8[b]	12/28/58 - 12/27/59	2.00	1.5	1.9	7.4	1.8	31.0	1.22	25.4
Mi. 4.5	10/23/58 - 11/3/59	1.86	0.54	0.53	1.14	0.23	4.9	0.22	22.3

[a] Weighted average $(MPC)_w$ calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in the NBS Handbook 69.

[b] Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

* None detected.

TABLE VIII

EXTERNAL GAMMA RADIATION LEVELS

mr/hr

1959

Station Number	Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1	Solway Gate	.022	.026	.028	.027	.033	.028	.025	.019	.020	.015	.106	none taken	.024
2	Y-12 East Portal	.016	.021	.024	.020	.026	.017	.022	.015	.019	.014	.013	"	.019
3	Newcomb Road Oak Ridge	.018	.020	.025	.023	.026	.024	.023	.015	.022	.016	-	"	.021
4	Gallaher Gate	.025	.025	.030	.030	.032	.034	.025	.021	.025	.022	-	"	.027
5	White Wing Gate	.031	.028	.022	.032	.029	.035	.036	.018	.025	.019	.019	"	.027
Average														.024

OAK RIDGE GASEOUS DIFFUSION PLANT (K-25)

The results of environmental sampling by the ORGDP during 1959 indicate little, if any, radioactive material contamination of air, soil, or water either inside the plant boundaries or in the plant environs. In all cases, values measured were only small fractions of the recommended maximum permissible concentrations.

With respect to air-borne contamination, monitoring of the general air well within plant boundaries (averaging about 225 eight-hour samples per quarter) revealed no indication of activities approaching the permissible limits (general population) within these boundaries for even short periods. Thus, it appears essentially impossible that any significant air contamination problems can occur outside the ORGDP area.

Plant wastes released into public waterways are monitored at least weekly to insure that the concentration of these materials in the streams leaving the plant boundaries does not exceed the permissible limits given in NBS Handbook No. 69 for drinking water for population in the neighborhood of a controlled area. Monitoring points in Poplar Creek and Clinch River are both upstream and downstream from ORGDP. There were no instances of water release at the plant boundaries above the long-term maximum permissible concentration even for as short a time as the weekly sampling period, and the average activity in Poplar Creek below the plant for the entire year was only 0.03% of the maximum permissible concentration for the discharge of natural uranium; the levels in the Clinch River were much less than this figure.

ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/cc \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissible (MPC)	Av. Pl. Exp./MPC
Local Streams (Water)							
Poplar Creek	Uranium Concentration						
Upstream		52	3.7	8.7	6.2	2000	0.31%
Downstream	"	52	0.5	1.0	0.6	2000	0.03%
Clinch River							
Upstream	"	52	0.08	0.2	0.1	2000	0.005%
Downstream	"	52	0.1	0.3	0.3	2000	0.015%
Poplar Creek	Total Beta Activity						
Upstream		52	14.0	22.0	18.0	2000	0.9%
Downstream	"	52	11.0	32.0	22.0	2000	1.1%
Clinch River							
Upstream	"	52	13.0	96.0	39.0	105*	37.0%
Downstream	"	52	10.0	136.0	50.0	105*	48.0%

Normal Sampling Frequency: Continuous sampling; composited over one week.

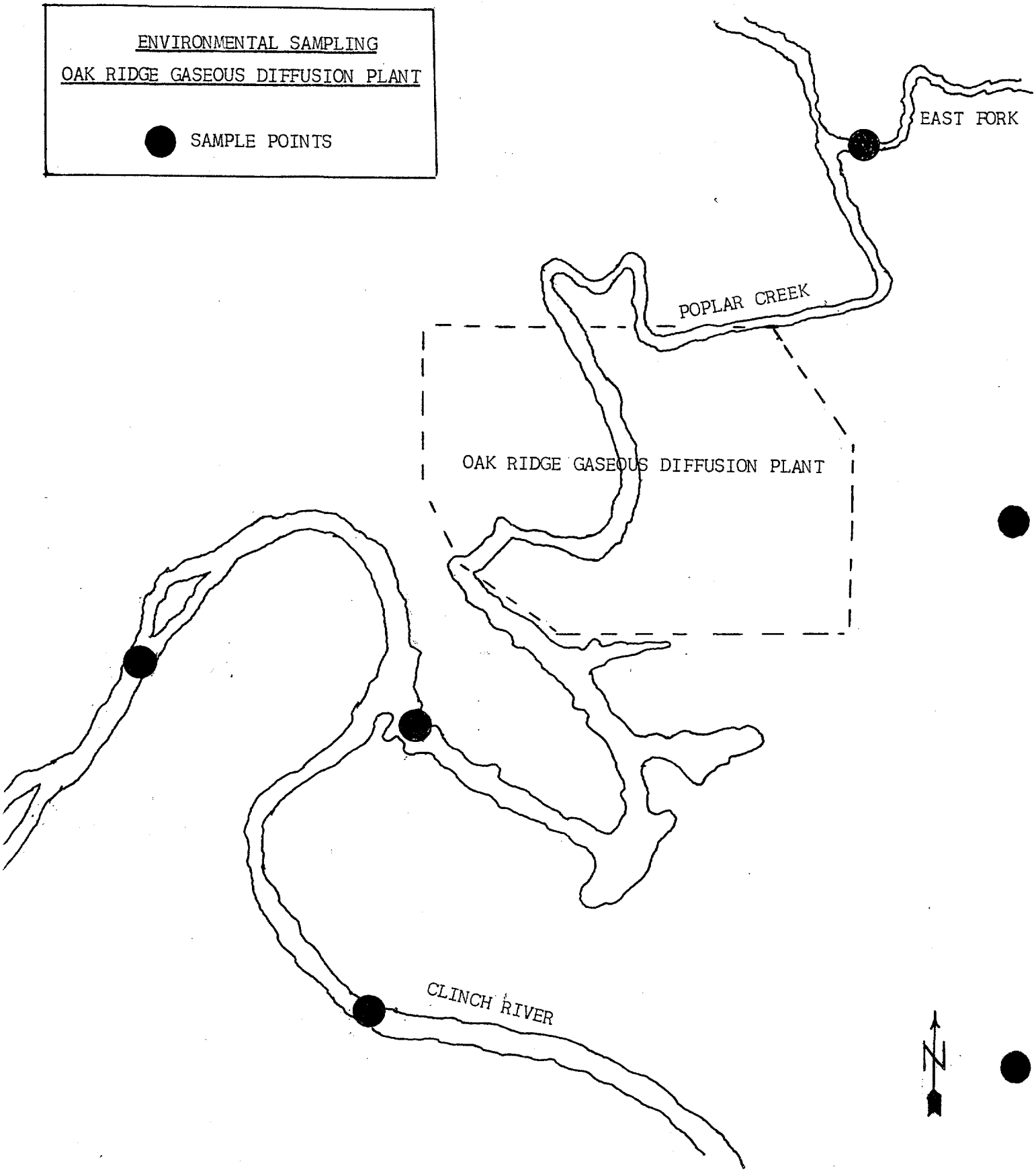
* Measured mixture of radionuclides.

ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT

1959

Location of Point	Type of Analysis Made	No. of Samples	Concentration ($\mu c/g \times 10^{-8}$) Plant Experience Low	High	Av.	Max. Permissibl (MPC)
Stream Bottom (Mud)						
Poplar Creek	Uranium Concentration					
Upstream		4	400	6900	3200	None Specified
Downstream	"	4	1300	4500	2500	
Clinch River						
Downstream	"	4	300	1300	700	
Poplar Creek	Total Beta Activity					
Upstream		4	7200	28,600	18,000	None Specified
Downstream	"	4	12,900	21,200	18,500	
Clinch River						
Downstream	"	4	15,800	79,200	45,500	

Normal Sampling Frequency: Grab sample, once each quarter at each location.


ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT
SAMPLE POINTS
EAST FORK
POPLAR CREEK
OAK RIDGE GASEOUS DIFFUSION PLANT
CLINCH RIVER
N

Y-12 PLANT

The Y-12 Plant does not monitor the air and water outside the plant area. However, in-plant monitoring indicates that the plant levels are well below the limits for environmental levels.

800833

May 28, 1960

ENVIRONMENTAL LEVELS OF RADIOACTIVITY FOR THE OAK RIDGE AREA

Report for 1959

Data Compiled by: H. H. Abee

APPROVAL FOR RELEASE

Document: # Unnumbered ; Date 5/28/60 ;

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Irwin Smith 1/29/93

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#506

Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to earthen pits located in the Conasauga shale formation. Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

Air Monitoring

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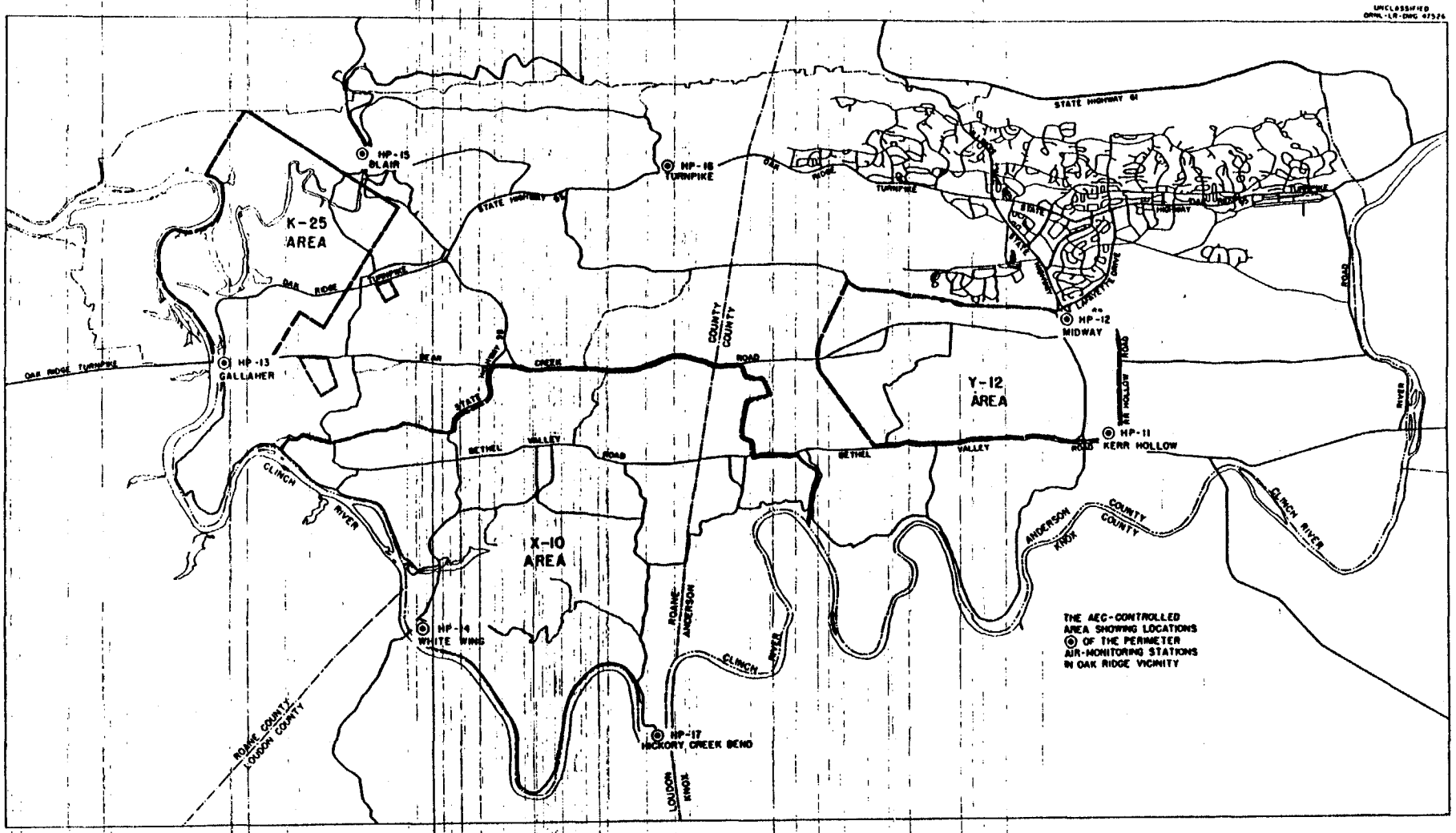
Three types of samples are collected at the stations. One type is taken by passing air continuously through filter paper. The filter paper will collect only those particulates considered to be respirable. A second type utilizes a gummed paper technique for collecting fall-out The fall-out trays collect the heavier particles as well as the respirable particles. A third type is rain water which provides data for determining the soluble and insoluble fractions of the radioactive contamination.

Data obtained from the various sampling methods are accumulated and tabulated. In the case of the filter samples, data are tabulated in average $\mu c/cc$ of air sampled and numbers of particles per 1000 ft^3 of air sampled. In the case of gummed paper fall-out collection, data are tabulated in $\mu c/ft^2$ and numbers of particles per ft^2. In the case of rain water, data are tabulated in average $\mu c/cc$ of rainfall collected. The data are compared to established maximum permissible concentrations and with previous averages.

Water Monitoring

Large volume, low-level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population in the neighborhood of a controlled area as recommended by the National Committee on Radiation Protection (NCRP). The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.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HP-13
GALLAHER
HP-12
MIDWAY
Y-12
AREA
HP-11
KERR HOLLOW
BETHEL VALLEY ROAD
CLINCH RIVER
X-10
AREA
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WHITE WING
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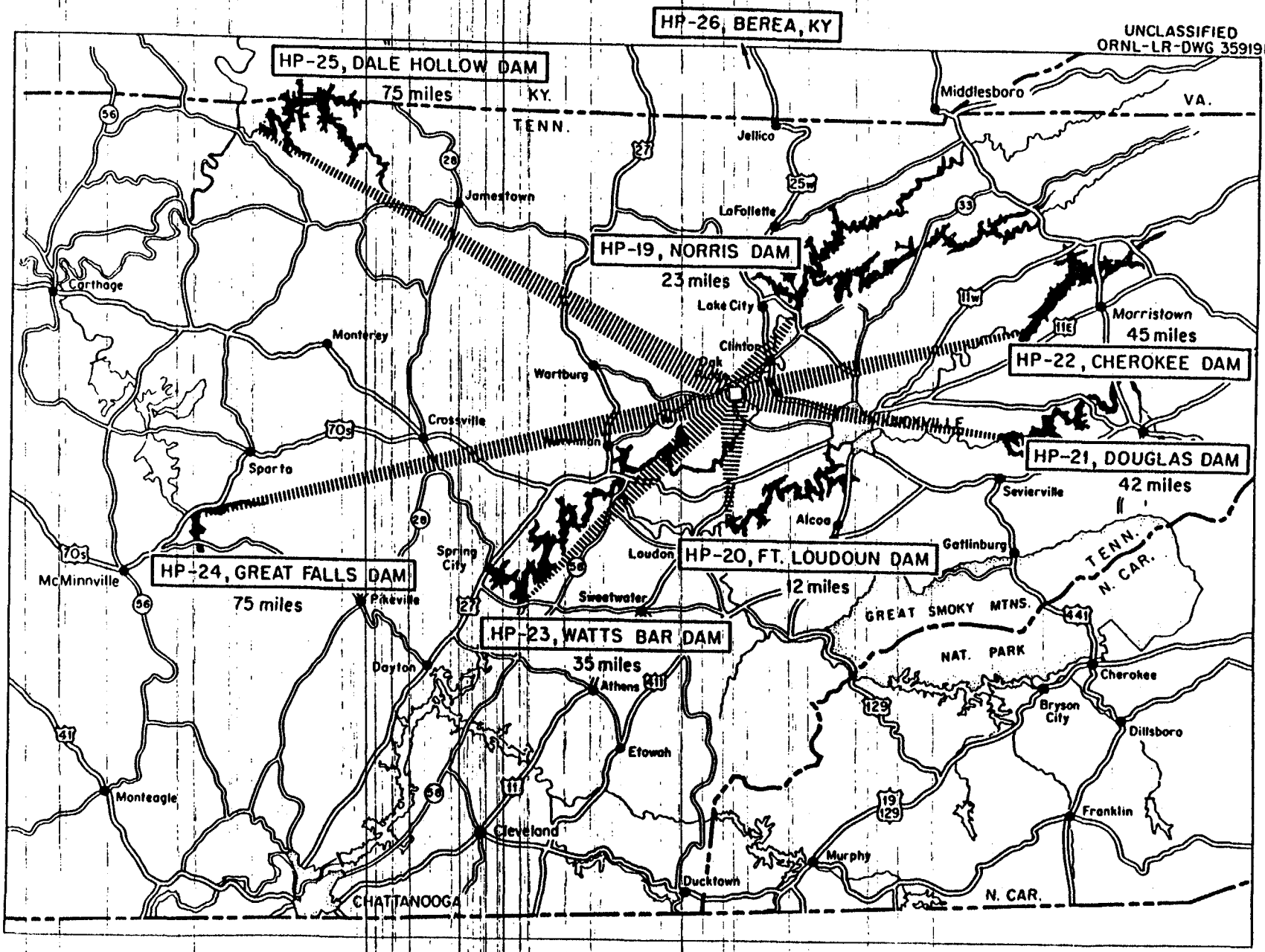
HICKORY CREEK BEND
ROANE COUNTY
LOUDON COUNTY
ANDERSON COUNTY
KNOX COUNTY
THE AEC-CONTROLLED
AREA SHOWING LOCATIONS
◎ OF THE PERIMETER
AIR-MONITORING STATIONS
IN OAK RIDGE VICINITY

Figure 1



STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Figure 2

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 3 and 4. Samples are taken in Poplar Creek and White Oak Creek prior to entry of the wastes into the public waterway and at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river.

The fraction of the total beta activity comprised by each isotope is determined from analysis of long-lived radionuclides contained in the effluent and a weighted average maximum permissible concentration for water, $(MPC)_w$, for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as recommended by the NCRP. The average concentrations of radioactivity in the Clinch River are compared to the calculated $(MPC)_w$ value.

Annual surveys of the Clinch and Tennessee Rivers are conducted to determine the extent of dispersion of radioactive material in river sediment. This survey is required in order to determine whether or not there is a significant build-up of radioactive constituents in the river system. Gamma radiation measurements are made on the bottom sediments. Sediment samples are radiochemically analyzed for long-lived radioactive isotopes.

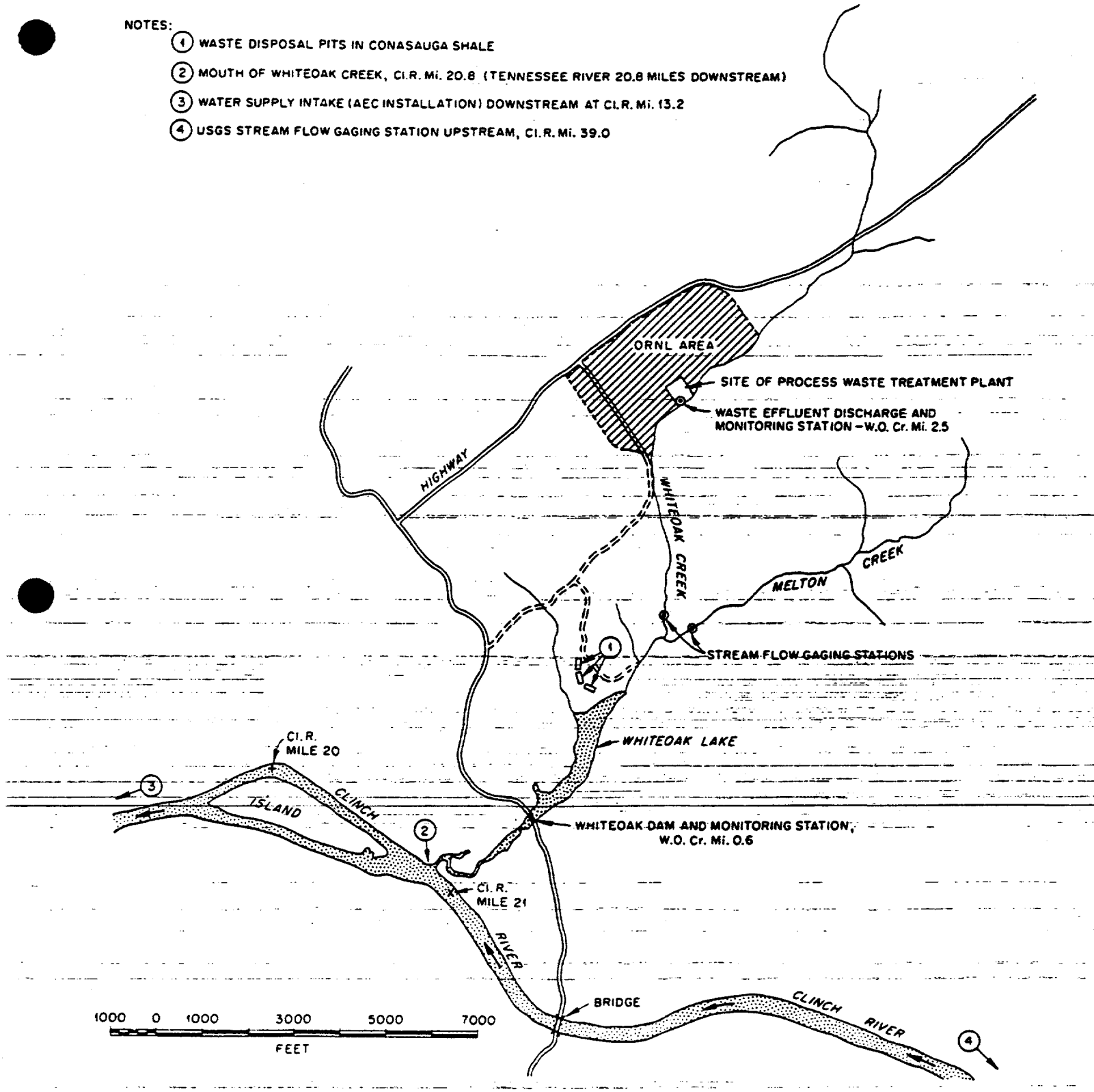
Gamma Measurements

External gamma radiation levels are measured monthly at five locations in the Oak Ridge area. Measurements are taken with a Geiger-Muller tube at a distance of three feet above ground and the results are tabulated in terms of mr/hr.

Discussion of Data

Data accrued from the monitoring system in 1959 are presented in Tables I through X.

The air contamination levels shown by the continuous air monitoring systems for the immediate and remote environs of the Oak Ridge area were 1.6% and 1.4% respectively of the maximum permissible concentration for populations in the neighborhood of a controlled area. Air contamination levels during the first half of 1959 were a factor of 4 to 6 times greater than the average for the entire year. By the end of 1959 air contamination levels had decreased to approximately 1/5 the value given for the yearly



Location Sketch Map
ORNL Area Surface Drainage

Figure 3

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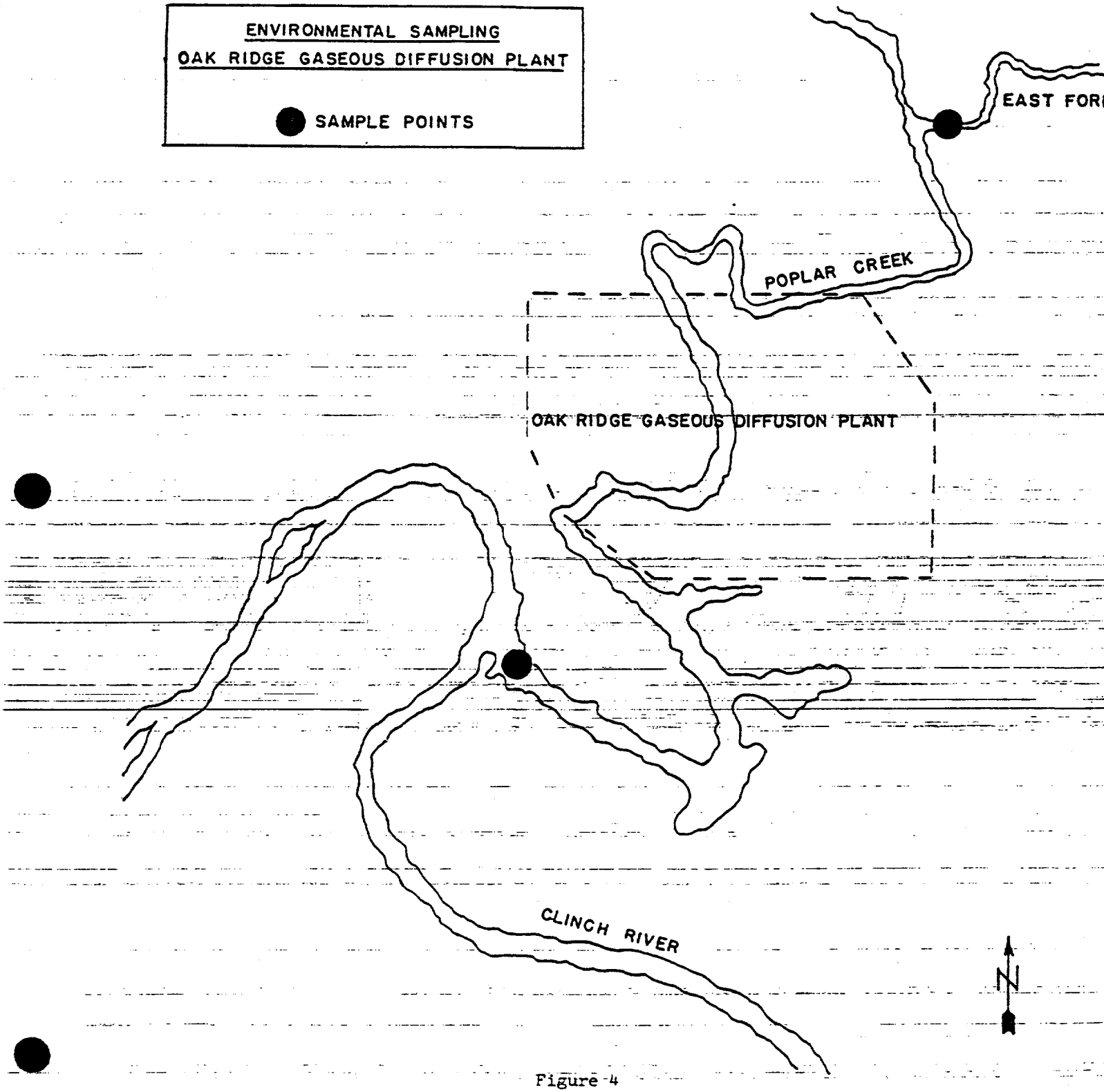

Figure 4

average. Specific analysis for fission products and decay studies indicated that the high levels experienced during the first part of the year were due to the type of fall-out from world-wide weapons testing. The low values for remote stations 23 and 24 resulted from the fact that these stations were in operation only during the latter half of 1959 and do not reflect the higher fall-out levels experienced during the first half of the year.

Fall-out data and rain water data followed the same trend shown by the continuous air monitoring data.

The probable average concentrations of radioactivity in the Clinch River at Mile 20.8, the point of entry of the wastes, and at Mile 4.5, near Kingston, Tennessee, were 3.1×10^{-7} μc/cc and 4.9×10^{-8} μc/cc respectively. These values are 25.4% and 22.3% of the weighted average maximum permissible concentration for populations in the neighborhood of a controlled area as recommended by the NCRP. The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 3×10^{-10} μc/cc, which is 0.03% of the weighted average $(MPC)_w$ value. The average activity in Poplar Creek below the ORGDP for the entire year was only 0.03% of the maximum permissible concentration for natural uranium.

The concentration of radioactivity in the sediment of the Clinch River drops off materially after the first 20 miles downstream from the entry of White Oak Creek and approaches background levels 200 miles downstream. The average radiation level for the cross section where the highest levels were encountered was approximately 19 times the measured background levels or 0.12 mr/hr. This point is located 4.5 miles below the outfall of White Oak Creek. At 100 miles downstream the average level was approximately twice background.

External gamma radiation levels in the Oak Ridge area averaged 0.024 mr/hr. This level does not differ significantly from the average of the levels measured throughout the United States by the U. S. Public Health Service Radiation Surveillance Network.

TABLE I

CONTINUOUS AIR MONITORING FILTER DATA

Units of 10^{-13} µc/cc

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average	% of $(MPC)_a$
		Perimeter Stations				
HP-11	Kerr Hollow Gate	52	47.52	0.49	15.77	1.6
HP-12	Midway Gate	49	81.31	0.08	16.29	1.6
HP-13	Gallaher Gate	52	58.52	0.54	16.63	1.7
HP-14	White Wing Gate	52	42.48	0.49	11.30	1.1
HP-15	Blair Gate	52	61.06	0.45	19.97	2.0
HP-16	Turnpike Gate	52	51.61	0.28	13.48	1.4
HP-17	Hickory Creek Bend	52	60.27	0.17	16.86	1.7
Average					15.76	1.6
		Remote Stations				
HP-19	Norris Dam	52	86.20	0.57	23.23	2.3
HP-20	Loudoun Dam	52	90.49	0.65	22.11	2.2
HP-21	Douglas Dam	37	58.17	0.68	10.91	1.1
HP-22	Cherokee Dam	36	100.52	0.52	16.01	1.6
HP-23**	Watts Bar Dam	29	35.14	0.49	5.13	0.5
HP-24**	Great Falls Dam	26	10.58	0.24	2.53	0.3
HP-25	Dale Hollow Dam	46	78.91	0.76	18.04	1.8
HP-26	Berea, Kentucky	52	54.27	0.14	13.77	1.4
Average					13.97	1.4

* $(MPC)_a$ is taken to be 10^{-10} µc/cc as recommended in NBS Handbook 69, Table 4, p. 94.
** Stations in operation only during latter half of 1959.

TABLE II

CONTINUOUS AIR MONITORING FILTER DATA

Particles/1000 cu. ft. of Air Sampled

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	6.27	0.00	1.20
HP-12	Midway Gate	49	6.81	0.00	1.29
HP-13	Gallaher Gate	52	5.08	0.00	0.95
HP-14	White Wing Gate	52	5.91	0.00	0.82
HP-15	Blair Gate	52	10.29	0.00	1.52
HP-16	Turnpike Gate	52	5.39	0.00	0.86
HP-17	Hickory Creek Bend	52	7.22	0.00	1.02
Average					1.09
		Remote Stations			
HP-19	Norris Dam	52	7.98	0.00	1.64
HP-20	Loudoun Dam	52	6.61	0.00	1.43
HP-21	Douglas Dam	37	2.83	0.00	0.28
HP-22	Cherokee Dam	39	7.26	0.00	0.54
HP-23*	Watts Bar Dam	29	0.40	0.00	0.05
HP-24*	Great Falls Dam	26	0.14	0.00	0.02
HP-25	Dale Hollow Dam	46	7.96	0.00	1.01
HP-26	Berea, Kentucky	52	5.83	0.00	1.10
Average					0.76

* Stations in operation only during latter half of 1959.

TABLE III

GUMMED PAPER FALL-OUT DATA

Units of 10^{-4} μc/sq. ft.

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	17.59	0.14	5.01
HP-12	Midway Gate	52	18.64	0.23	5.01
HP-13	Gallaher Gate	52	17.15	0.18	4.63
HP-14	White Wing Gate	52	16.87	0.18	4.86
HP-15	Blair Gate	52	23.55	0.15	5.37
HP-16	Turnpike Gate	52	28.88	0.15	5.03
HP-17	Hickory Creek Bend	52	15.17	0.14	4.41
Average					4.90
		Remote Stations			
HP-19	Norris Dam	52	23.53	0.12	4.36
HP-20	Loudoun Dam	51	14.97	0.05	4.17
HP-21	Douglas Dam	37	15.20	0.04	1.99
HP-22	Cherokee Dam	39	13.45	0.07	2.51
HP-23*	Watts Bar Dam	28	4.55	0.10	0.71
HP-24*	Great Falls Dam	26	2.75	0.12	0.63
HP-25	Dale Hollow Dam	46	20.75	0.14	4.26
HP-26	Berea, Kentucky	52	22.02	0.05	4.88
Average					2.94

* Stations in operation only during latter half of 1959.

TABLE IV

GUMMED PAPER FALL-OUT DATA

Particles/sq. ft.

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	52	77.00	0.00	11.96
HP-12	Midway Gate	52	97.00	0.00	12.85
HP-13	Gallaher Gate	52	84.00	0.00	10.50
HP-14	White Wing Gate	52	82.00	0.00	10.13
HP-15	Blair Gate	52	97.00	0.00	12.15
HP-16	Turnpike Gate	52	76.00	0.00	9.50
HP-17	Hickory Creek Bend	52	59.00	0.00	9.50
Average					10.94
		Remote Stations			
HP-19	Norris Dam	52	47.00	0.00	6.23
HP-20	Loudoun Dam	31	46.00	0.00	5.27
HP-21	Douglas Dam	37	14.00	0.00	0.51
HP-22	Cherokee Dam	39	11.00	0.00	0.90
HP-23*	Watts Bar Dam	28	3.00	0.00	0.41
HP-24*	Great Falls Dam	26	3.00	0.00	0.19
HP-25	Dale Hollow Dam	46	59.00	0.00	4.54
HP-26	Berea, Kentucky	52	63.00	0.00	7.19
Average					3.16

* Stations in operation only during latter half of 1959.

TABLE V

RADIOACTIVITY IN RAIN WATER

Units of 10^{-7} μc/cc

1959

Station Number	Location	Number of Samples Taken	Maximum	Minimum	Average
		Perimeter Stations			
HP-11	Kerr Hollow Gate	44	42.59	0.11	7.22
HP-12	Midway Gate	44	40.38	0.14	6.30
HP-13	Gallaher Gate	44	38.72	0.12	6.10
HP-14	White Wing Gate	43	43.47	0.09	6.53
HP-15	Blair Gate	39	39.36	0.19	5.78
HP-16	Turnpike Gate	44	54.84	0.15	8.82
HP-17	Hickory Creek Bend	43	54.18	0.10	8.14
Average					6.98
		Remote Stations			
HP-19	Norris Dam	45	89.98	0.13	11.26
HP-20	Loudoun Dam	49	138.47	0.04	14.65
HP-21	Douglas Dam	31	36.68	0.06	3.86
HP-22	Cherokee Dam	33	32.20	0.13	4.41
HP-23*	Watts Bar Dam	23	6.89	0.20	1.32
HP-24*	Great Falls Dam	21	8.22	0.07	1.41
HP-25	Dale Hollow Dam	41	41.00	0.21	8.02
HP-26	Berea, Kentucky	44	47.28	0.14	10.14
Average					6.88

* Stations in operation only during latter half of 1959.

TABLE VI

PROBABLE AVERAGE CONCENTRATION OF RADIOACTIVITY
IN THE CLINCH RIVER AT MILE 20.8

Units of 10^{-7} μc/cc

1959

Number of Samples Taken	Maximum	Minimum	Average	% of $(MPC)_w$
365	36.4	0.37	3.1	25.4

TABLE VII

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSITUENTS IN THE CLINCH RIVER

1959

Location	Sampling Period	Units of 10-8 µc/cc Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	Probable Avg. Concen. of Radioactivity µc/cc x 10-8	$(MPC)_w^a$ 10-6 µc/cc	% of MPC
Clinch River									
Mi. 37.5	10/1/59 - 1/29/60	0.11	0.10	*	*	*	0.45	0.21	2.14
Mi. 20.8[b]	12/28/58 - 12/27/59	2.00	1.5	1.9	7.4	1.8	31.0	1.22	25.4
Mi. 4.5	10/23/58 - 11/3/59	1.86	0.54	0.53	1.14	0.23	4.9	0.22	22.3

[a] Weighted average $(MPC)_w$ calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in the NBS Handbook 69.

[b] Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

* None detected.

TABLE VIII

EXTERNAL GAMMA RADIATION LEVELS

mr/hr

1959

Station Number	Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1	Solway Gate	.022	.026	.028	.027	.033	.028	.025	.019	.020	.015	.016	none taken	.024
2	Y-12 East Portal	.016	.021	.024	.020	.026	.017	.022	.015	.019	.014	.013	"	.019
3	Newcomb Road Oak Ridge	.018	.020	.025	.023	.026	.024	.023	.015	.022	.016	-	"	.021
4	Gallaher Gate	.025	.025	.030	.030	.032	.034	.025	.021	.025	.022	-	"	.027
5	White Wing Gate	.031	.028	.022	.032	.029	.035	.036	.018	.025	.019	.019	"	.027
Average														.024

TABLE IX

CONCENTRATION OF RADIOACTIVITY IN POPLAR CREEK

1959

Location of Point	Type of Analysis Made	No. of Samples	Units of 10^{-8} µc/cc				
			Maximum	Minimum	Average	$(MPC)_w$	Percent $(MPC)_w$
Upstream (East Fork)	Uranium Concentration	52	8.7	3.7	6.2	2000	0.31
Downstream (Outfall)	"	52	1.0	0.5	0.6	2000	0.03
Upstream (East Fork)	Total Beta Activity	52	22.0	14.0	18.0	2000	0.9
Downstream (Outfall)	"	52	32.0	11.0	22.0	2000	1.1

Normal Sampling Frequency: Continuous sampling; composited over one week.

TABLE X

RADIOACTIVITY IN THE BOTTOM SEDIMENT OF POPLAR CREEK

Units of 10^{-8} μc/g

1959

Location of Point	Type of Analysis Made	No. of Samples	Maximum	Minimum	Average
Upstream (East Fork)	Uranium Concentration	4	6900	400	3200
Downstream (Outfall)	"	4	4500	1300	2500
Upstream (East Fork)	Total Beta Activity	4	28,600	7200	18,000
Downstream (Outfall)	"	4	21,200	12,900	18,500

Normal Sampling Frequency: Grab sample, once each quarter at each location.